PTO/SB/01 (06-03)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

[X] Declaration Submitted With Initial Filing **OR** [ ] Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	STL11361
First Named Inventor	Stanton M. Keeler
COMPLETE IF KNOWN	
Application Number	
Filing Date	
Art Unit	
Examiner Name	

I hereby declare that:

Each inventor's residence, mailing address, and citizenship are as stated below next to their name.

I believe the inventor(s) named below to be the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

MULTI-LEVEL CACHING IN DATA STORAGE DEVICES

(Title of the Invention)

the specification of which

[X] is attached hereto

OR

[ ] was filed on (MM/DD/YYYY) [ ] as United States Application Number or PCT International Application Number [ ] and was amended on (MM/DD/YYYY) [ ] (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? Yes	Certified Copy Attached? No
			[X]	[ ]	[X]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]
			[ ]	[ ]	[ ]

[ ] Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

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DECLARATION — Utility or Design Patent Application

Direct all correspondence to: ☐ Customer Number: _____ OR ☒ Correspondence address below

Name
Kirk A. Cesari, Seagate Technology LLC

Address
1280 Disc Drive

City	State	ZIP
Shakopee	MN	55379

Country	Telephone	Fax
	1-952-402-3534	1-952-402-2657

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAME OF SOLE OR FIRST INVENTOR: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname
Stanton M.	Keeler

Inventor's Signature: Stanton M Keeler — Date: 9/22/03

Residence: City	State	Country	Citizenship
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Mailing Address
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City	State	ZIP	Country
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NAME OF SECOND INVENTOR: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname

Inventor's Signature — Date

Residence: City	State	Country	Citizenship
		e	

Mailing Address

City	State	ZIP	Country

☒ Additional inventors or a legal representative are being named on the 1 supplemental sheet(s) PTO/SB/02A or 02LR attached hereto.

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s):	Stanton Keeler		
Serial No.:		Examiner:	
Filed:	9-24-2003	Group Art Unit:	
Title:	Multi-Level Caching In Data Storage Devices		
Docket:	STL11361		

POWER OF ATTORNEY BY ASSIGNEE OF ENTIRE INTEREST
(REVOCATION OF PRIOR POWERS)

As assignee of record of the entire interest of the above identified application,

REVOCATION OF PRIOR POWERS OF ATTORNEY

all powers of attorney previously given are hereby revoked and

NEW POWER OF ATTORNEY

the following practitioners/patent agent are hereby appointed to prosecute and transact all business in the Patent and Trademark Office connected therewith.

Shawn B. Dempster, Registration No. 34,321	Raghunath S. Minisandram, Registration No. 38,683
Derek J. Berger, Registration No. 45,401	Mitchell K. McCarthy, Registration No. 38,794
Kirk A. Cesari, Registration No. 47,479	Carol I. Bordas, Registration No. 37,284
Paul T. Dietz, Registration No. 38,858	Jennifer M. Buenzow, Registration No. 50,124
David K. Lucente, Registration No. 36,202	Joseph F. Villella, Jr., Registration No. 30,599
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CHANGE OF ATTORNEY'S/AGENT'S ADDRESS IN APPLICATION

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(952) 402-3534 (telephone)
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STATEMENT UNDER 37 CFR 3.73(b)

Seagate Technology LLC states that it is the Assignee of Entire Interest in the patent application/patent identified above by virtue of an Assignment from the inventor(s) of the patent application/patent identified above. A copy of the Assignment is attached and/or was recorded in the Patent and Trademark Office at Reel , Frame . The undersigned (whose title is supplied below) is empowered to sign this statement on behalf of the Assignee.

Respectfully submitted,

SEAGATE TECHNOLOGY LLC
(Assignee of Entire Interest)

9-24-2003
Date

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PTO/SB/16 (10-01)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. EV 062764992 US

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Hui	Su	Longmont, CO
Steven S	Williams	Longmont, CO

☐ *Additional inventors are being named on the _____ separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

Fast Disc Write Mechanism in Hard Disc Drives

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

☐ Customer Number [ ] → *Place Customer Number Bar Code Label here*

OR *Type Customer Number here*

☒ Firm or Individual Name	Seagate Technology LLC				
Address	Intellectual Property Department - COL2LGL				
Address	389 Disc Drive				
City	Longmont	State	CO	ZIP	80503-0001
Country		Telephone	720-684-2265	Fax	720-684-2588

ENCLOSED APPLICATION PARTS (check all that apply)

☒ Specification *Number of Pages* 2 ☐ CD(s), Number [ ]

☐ Drawing(s) *Number of Sheets* [ ] ☐ Other (specify) [ ]

☐ Application Data Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

		FILING FEE AMOUNT ($)
☐	Applicant claims small entity status. See 37 CFR 1.27.	
☐	A check or money order is enclosed to cover the filing fees	
☒	The Commissioner is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: 19-1038	160.00
☐	Payment by credit card. Form PTO-2038 is attached.	

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☒ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: _____

Respectfully submitted,

SIGNATURE _____ Date 07/01/02

TYPED or PRINTED NAME Derek J Berger REGISTRATION NO. *(if appropriate)* 45,401

TELEPHONE 720-684-2265 Docket Number: STL10927.01

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

This collection of information is required by 37 CFR 1.51. The information is used by the public to file (and by the PTO to process) a provisional application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the complete provisional application to the PTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S.D Department of Commerce, Washington, D.C. 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Box Provisional Application, Assistant Commissioner for Patents, Washington, D.C. 20231.

Fast Disc Write Mechanism in Hard Disk drives

Over next 4 to 6 years, the interface speed of hard disc drive will be doubled or even tripled. Serial ATA timeline is 150 MB/s at 2002, 300 MB/s at 2004 and 600 MB/s at 2007; SCSI timeline is 640 MB/s at 2004 and 1280 MB/s at 2006. However, because of physical limitation of GMR head and magnetic media, disk data rate will not increase as dramatically as interface speed. There exists a big gap between disk data rate and host interface speed. There are so many mechanisms to improve data reading from media such as caching, pre-fetching, large buffer etc. Compared with data read, disc write is the bottleneck for hard disc drive performance. Disc write will even get worse when data is written onto various parts of the hard disc drive that are at slow access time and low data rate inner zone (Inside Diameter).

This will propose a fast disc write mechanism to improve hard disc drive write performance. Programmable disk space (up to several hundred MB) at OD (Outside Diameter) for fast access time and high data rate is allocated for usage of the fast disk write mechanism. There are some predefined conditions that will invoke the fast disk write, such as file size, file location (OD, ID (Inside Diameter)) and file distribution (one place or multiple palaces). These threshold parameters are programmable also. When the fast disk write mode is on, every time the host sends write data, the disc drive controller will determine whether the file information meets thresholds. If yes, disc drive controller will first write the file to the allocated space, then write file information (PBA or LBA, file size, PBA for allocated space) to non-volatile writeable RAM-based memory, such as Ferroelectric RAM (FRAM), Magnetoresistive RAM (MRAM), etc. When host is not using the hard drive, the data file stored temporally at allocated space will be written to appropriate locations. Through FRAM, MRAM, other non-volatile writeable RAM-based memory, Fast Disc Write Logic block will track the files at allocated space, such as links, the number of outstanding files in allocated space and empty space size left in allocated space, etc. The important and relevant information is stored in FRAM, MRAM or other non-volatile writable RAM-based memories. So information of outstanding files will not be lost when power fails.

Fast Disc Write Logic block will also check for overlaps between new commands from the host and existing data that has been previously placed in the fast write allocated space. When new write commands overlap data in the fast write space, the older data can be discarded or replaced. When the host issues read commands to the disc drive, the Fast Disc Write Logic block will first check the file locations: allocated space or non-allocated space, then help disc formatter to read the file from appropriate location.

In order to keep track of what data is in the fast write space, the hardware will have to maintain a list of "segments" in a format such as this:

Data	Size	
Starting LBA	48 bits	First LBA of this block of data
Valid Sectors	16 bits	Number of consecutive valid sectors
Total Sectors	16 bits	Number of disk sectors allocated to this block

Maintaining the "Total sectors" and "Valid Sectors" entries allows part or all of a given block to be invalidated. Optionally, the data structure could have a "starting offset" being the offset in the reserved fast write area to the first sector of a block. This would make the "Total Sectors" field unnecessary, but could be useful if the list is kept as a linked list (ordered). A third option would be to have separate descriptors for all unused blocks. Hardware automation for searching these blocks for overlaps and or free space when needed should make it feasible to have a large number of entries.